

Claims

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1. A duplexing communication signal filter for connection to an antenna, a transmitter and a receiver, the signal filter suitable for filtering an incoming signal from the antenna to the receiver and for filtering an outgoing signal from the transmitter to the antenna, the filter comprising:
- 5 a substantially U-shaped core of dielectric material including a transmit arm, a receive arm and a base portion joining the transmit arm to the receive arm, each arm having an inwardly facing surface and an outwardly facing surface and each arm defining a series of through-
- 10 holes, each through-hole extending through the arm between an opening at the inwardly facing surface and an opening at the outwardly facing surface; and
- a pattern of metallized and unmetallized areas on the core including,
- 15 a wide area of metallization for providing off-band signal absorption,
- a first unmetallized area surrounding a plurality of the through-hole openings on the outwardly facing surface of the transmit arm,
- 20 a second unmetallized area surrounding a plurality of the through-hole openings on the outwardly facing surface of the receive arm,
- a transmitter pad metallized area on the transmit arm for receiving the outgoing signal,
- 25 a receiver pad metallized area on the receive arm for providing the incoming signal,
- an antenna pad metallized area on the base portion for

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receiving the incoming signal and outputting the outgoing signal,  
and

a bridge metallized area extending between the transmit arm  
and the receive arm.

5            2. The filter according to claim 1 wherein the core further  
defines a bridge through-hole extending between the transmit arm  
outwardly facing surface and the receive arm outwardly facing surface,  
the bridge through-hole having side walls and the bridge metallized area  
being present on the side walls of the bridge through-hole.

10          / 3. The filter according to claim 1 wherein the base has an  
outside surface opposite the transmit arm and the receive arm, and the  
bridge metallized area is a strip on the outside surface.

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15          / 4. The filter according to claim 3 wherein the base has a  
groove from the outside surface and the bridge metallized area is a strip  
in the groove.

5. The filter according to claim 1 exhibiting a filtering passband  
for the outgoing signal from about 1850 MHz to about 1910 MHz and  
exhibiting filtering passband for the incoming signal from about 1930  
MHz to about 1990 MHz.

20          6. The filter according to claim 5 with a length of at most about  
17 millimeters.

7. The filter according to claim 5 with a maximum linear  
dimension of at most about 17 millimeters.

25          8. The filter according to claim 5 with a surface mount height of  
at most about 4 millimeters.

9. The filter according to claim 1 exhibiting a filtering passband  
for the outgoing signal of about 1850 MHz to about 1910 MHz with an

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ambient temperature maximum insertion loss over the outgoing signal passband of at most about 2.51 decibels (dB).

10. The filter according to claim 1 exhibiting a filtering passband for the incoming signal from about 1930 MHz to about 1990 MHz with an ambient temperature maximum insertion loss over the incoming signal passband of at most about 4.34 decibels (dB).

11. The filter according to claim 1 having a length of at most about 17 millimeters.

12. The filter according to claim 1 wherein <sup>send</sup> antenna pad is positioned on the base portion towards the transmit arm.

13. The filter according to claim 1 wherein <sup>send</sup> antenna pad is positioned on the base portion towards the receive arm.

14. The filter according to claim 1 wherein the transmitter pad is spaced apart from the base portion along a length of the transmit arm.

15. The filter according to claim 1 wherein the receiver pad is spaced apart from the antenna pad along a length of the receive arm.

16. The filter according to claim 1 wherein the transmit arm has a base side and an opposing distal end and the transmitter pad is positioned such that at least one of the through-holes is present between the transmitter pad and the distal end.

17. The filter according to claim 1 wherein the transmit arm includes at least one through-hole configured to be a signal trapping resonator.

18. The filter according to claim 1 wherein the receive arm includes at least one through-hole configured to be a signal trapping resonator.

19. The filter according to claim 1 wherein the transmit arm

outwardly facing surface has a metallization pattern as shown in FIG. 2.

20. The filter according to claim 1 wherein the receiver arm outwardly facing surface has a metallization pattern as shown in FIG. 3.

21. The filter according to claim 1 wherein the series of through-holes defined by the transmit arm are each axially aligned with the series of through-holes defined by the receiver arm.

22. A duplexing communication signal filter for connection to an antenna, a transmitter and a receiver, the signal filter suitable for filtering an incoming signal from the antenna to the receiver and for filtering an outgoing signal from the transmitter to the antenna, the filter comprising:

a first and a second rigid core of dielectric material, each core having a substantially rectangular parallelepiped shape with a top surface, a bottom surface and four side surfaces and each core defining a series of through-holes, each through-hole extending from an opening on the top surface to an opening on the bottom surface;

a first surface-layer pattern of metallized and unmetallized areas on the first core and including a first wide area of metallization for providing off-band signal absorption, a first unmetallized area substantially surrounding at least two of the openings on the top surface of the first core, a first bridge electrode extending between the top surface and the bottom surface, a transmitter connection pad of metallization for receiving the outgoing signal, and an antenna connection pad for receiving the incoming signal and outputting the outgoing signal;

a second surface-layer pattern of metallized and unmetallized areas on the second core and including a second wide area of metallization for providing off-band signal absorption, a second

unmetallized area substantially surrounding at least two of the openings on the top surface of the second core, a second bridge electrode extending between the top surface and the bottom surface, a receiver connection pad of metallization for providing the incoming signal; and  
5 a bond between each said bottom surface for joining the first core and the second core.

23. The filter according to claim 22 wherein the first bridge electrode extends through one of the through-holes of the first core and the second bridge electrode extends through one of the through-holes of  
10 the second core.

24. The filter according to claim 22 wherein the first bridge electrode and the second bridge electrode are present on mutually axially aligned through-holes of the first core and the second core, respectively.

25. The filter according to claim 24 wherein the first bridge electrode and the second bridge electrode are conductively linked by an insert.  
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26. The filter according to claim 22 wherein the first core has a first surface groove bearing the first bridge electrode and the second core has a second surface groove axially aligned with the first surface groove and bearing the second bridge electrode.  
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27. A duplexing communication signal filter for connection to an antenna, a transmitter and a receiver, the filter for filtering an incoming signal from the antenna to the receiver and for filtering an outgoing  
25 signal from the transmitter to the antenna, the filter comprising:

a first and a second rigid core of dielectric material, each core having a substantially rectangular parallelepiped shape with a top

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surface, a bottom surface and four side surfaces and each core defining a series of through-holes, each through-hole extending from an opening on the top surface to an opening on the bottom surface;

5 a first surface-layer pattern of metallized and unmetallized areas on the first core and including a first wide area of metallization for providing off-band signal absorption, a first unmetallized area substantially surrounding at least two of the openings on the top surface of the first core, a first bridge electrode extending between the top surface and the bottom surface, and a transmitter connection pad of  
10 metallization for receiving the outgoing signal;

a second surface-layer pattern of metallized and unmetallized areas on the second core and including a second wide area of metallization for providing off-band signal absorption, a second unmetallized area substantially surrounding at least two of the openings  
15 on the top surface of the second core, a second bridge electrode extending between the top surface and the bottom surface, a receiver connection pad of metallization for providing the incoming signal, and an antenna connection pad for receiving the incoming signal and outputting the outgoing signal, the second bridge electrode being conductively  
20 linked to the first bridge electrode; and

a bond between each said bottom surface for joining the first core and the second core.

28. A duplexing communication signal filter for connection to an antenna, a transmitter and a receiver, the signal filter for filtering an  
25 incoming signal from the antenna to the receiver and for filtering an outgoing signal from the transmitter to the antenna, the filter comprising:

a substantially U-shaped core of dielectric material including a first

arm, a second arm and a base portion joining the first arm to the second arm, each arm having an inwardly facing surface and an outwardly facing surface and each arm defining a series of through-holes, each through-hole extending through the arm between an opening on the inwardly facing surface and an opening on the outwardly facing surface;

5 and

a pattern of metallized and unmetallized areas on the core including,

10 a wide area of metallization for providing off-band signal absorption,

a first unmetallized area surrounding at least one of the through-hole openings on the outwardly facing surface of the transmit arm,

15 a second unmetallized area surrounding at least one of the through-hole openings on the outwardly facing surface of the receiver arm,

a transmitter pad metallized area on the first arm for receiving the outgoing signal,

20 a receiver pad metallized area on the second arm for providing the incoming signal,

an antenna pad metallized area on the base portion for receiving the incoming signal and outputting the outgoing signal, and

25 a bridge metallized area extending between the first arm outwardly facing surface and the second arm outwardly facing surface.

29. The filter according to claim 27 exhibiting a filtering

passband for the outgoing signal from about 1850 MHz to about 1910 MHz and exhibiting filtering passband for the incoming signal from about 1930 MHz to about 1990 MHz.

30. The filter according to claim 27 with a maximum linear dimension of at most 17 millimeters.

31. The filter according to claim 27 with a thickness of at most about 4 millimeters.

32. A duplexing communication signal filter adapted for connection to an antenna, a transmitter and a receiver for filtering an incoming signal from the antenna to the receiver and for filtering an outgoing signal from the transmitter to the antenna, the filter comprising:  
a substantially U-shaped core of dielectric material including a first arm, a second arm and a base portion joining the first arm to the second arm, each arm defining a series of through-holes extending through the arm; and  
a surface pattern of metallized and unmetallized areas on the core including,  
a wide area of metallization for providing off-band signal absorption,  
a first unmetallized area surrounding at least one of the through-holes of the transmit arm,  
a second unmetallized area surrounding at least one of the through-holes,  
a transmitter pad metallized area on the first arm for receiving the outgoing signal,  
a receiver pad metallized area on the second arm for providing the incoming signal,



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an antenna pad metallized area on the base portion for receiving the incoming signal and outputting the outgoing signal, and

a bridge metallized area extending between the first arm and the second arm being capacitively coupled to the antenna pad.

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33. A duplexing communication signal filter for connection to an antenna, a transmitter and a receiver, the signal filter suitable for filtering an incoming signal from the antenna to the receiver and for filtering an outgoing signal from the transmitter to the antenna, the filter comprising:

10 a substantially rectangular parallelepiped shaped core of rigid dielectric material defining a slot dividing the core into a transmit branch and a receive branch such that each branch has an inwardly facing surface and an outwardly facing surface, each branch defines a series of through-holes, each through-hole extending through the branch between an opening on the inwardly facing surface and an opening the outwardly facing surface; and

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a pattern of metallized and unmetallized areas on the core including,

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a wide area of metallization for providing off-band signal absorption,

a first unmetallized area surrounding a plurality of the through-hole openings on the outwardly facing surface of the transmitter branch,

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a second unmetallized area surrounding a plurality of the through-hole openings on the outwardly facing surface of the receiver branch,

a transmitter pad metallized area on the transmit branch for

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receiving the outgoing signal,

a receiver pad metallized area on the receive branch for providing an incoming signal,

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an antenna pad metallized area on the base portion for receiving the incoming signal and outputting the outgoing signal, and

a bridge metallized area extending between the transmit branch outwardly facing surface and the receive arm outwardly facing surface.

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